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THE PRACTICAL USE OF DISINFECTANTS.[1]

By H. E. HASSELTINE, Passed Assistant Surgeon, United States Public Health Service.

The subject of disinfection is one of great interest to health officials because it is inseparably connected with the control of communicable diseases. Each disease of that class depends on the existence of a specific organism of microscopic dimensions, which lives a parasitic life in the body of man or other members of the animal kingdom. On account of the minute size of these organisms, the ordinary mode of defense used against visible foes, mechanical power, is practically useless in the fight against infectious disease. For many centuries man lived in ignorance of these invisible enemies, fleeing before them when their effects made their presence known, or perhaps falling a helpless prey. When human intelligence ultimately demonstrated the presence of certain bacteria in the deadly epidemic diseases, that same intelligence began to seek for a means of defense.

The ancients used heat and sulphur for purposes probably more or less allied to the disinfection of the present day. When bacteriology became a field for scientific work, in the early eighties, the rational use of disinfectants began; since then they have been much used and much abused. In many instances it has been assumed that a disinfectant which is effective under the conditions of the experiments which proved its efficiency, is effective under other conditions. We are now beginning to find out that, probably, we have assumed too much concerning the action of disinfectants. There are two terms, often used synonymously, to which I desire to draw your attention at this point, viz, *disinfection* and *fumigation*. While they may be synonymous in certain cases, they are not necessarily so.

To *disinfect* is to free from infectious or contagious matter; to make innocuous. To *fumigate* is to apply smoke, gas, or vapor.

When we fill the hold of a vessel with sulphur dioxide in the absence of moisture, or with flue gas, or hydrocyanic-acid gas, for the purpose of destroying rats, mosquitoes, or other animal carriers of disease, we fumigate but do not thereby effect disinfection.

[1] Read before Annual Conference of State and Provincial Boards of Health of North America, at Washington, D. C., May 14, 1915.

If sufficient moisture be introduced with the sulphur dioxide, the gas then becomes a disinfectant vapor and attacks bacteria. A similar action takes place when formaldehyde gas is used under proper conditions. Therefore, disinfection and fumigation do not always mean the same thing.

In this paper, measures which attack the specific cause of disease directly will be considered as disinfecting measures; and as fumigating measures those which, by the use of gas, smoke, or vapor, attack the specific cause indirectly, through the destruction of intermediate hosts, or carriers other than man, such as mosquitoes, rats, fleas, flies, etc.

Bacteria, as well as men, have a "birth" rate and a death rate; both rates depend on environment. The birth rate is high under favorable conditions, and falls as the favorable conditions decrease. If the conditions continue unfavorable, a point is reached where the death rate exceeds the birth rate, and, unless more favorable environment is encountered, extinction is the inevitable result.

The natural processes of senile decay and death apply to the low minute organisms as well as to the more highly developed larger ones.

Hence, it follows that, within certain limits, we will have a natural disinfection, provided we wait long enough and the environment in which the organisms exist is unfavorable to their birth rate.

Artificial disinfection, or *disinfection,* as we call it, is the term applied to those processes which we use to increase the death rate of organisms in order to exterminate them in a shorter time than the natural processes will require.

It should be remembered that, whatever may be the death rate under any given conditions, it will require a proportionately longer time to kill the last few organisms. For instance, if there be 100 organisms present and the death rate be 75 per cent per minute, at the end of one minute there will be 25 organisms left; at the end of two minutes, approximately 7; at the end of three minutes, approximately 2; at the end of four minutes, less than 1. From a strictly mathematical point of view, absolute sterility will never be reached, but practically at the end of four minutes, the organisms being reduced to less than one, and a fraction of an organism being unable to germinate, we have reached a point which we call disinfection. This is the point the sanitarian is always striving for.

The questions which confront the sanitarian are: When shall disinfection be done, what agent shall be used, and how shall it be applied?

As regards the time when disinfection is to be done, we may consider two general periods, viz, during the disease, and after the case is terminated by recovery, death, or removal to other quarters.

1. *Use of disinfectants during the course of disease.*—All agree that disinfectants can be used with the greatest effect at the bedside of the patient. If done properly the necessity for terminal disinfection is lessened or perhaps removed. The patient is the source of infection. In most of the infectious diseases he is continually giving off virulent organisms in his secretions and excretions. These should be disinfected by proper means as soon as possible after being discharged; also all linen, bedding, dishes, and other utensils which necessarily come in contact with the patient. In some diseases it is not necessary to disinfect all discharges, though in case of doubt the errors should be made on the side of safety. In typhoid fever the feces and urine are highly infectious, but sputum, vomitus, and sweat may contain the bacilli and should also be treated. In such diseases as diphtheria the chief avenues by which the infection is given off are in the secretions of the nose and throat, rarely of the ear, and in the expired air as droplet infection. These discharges should be received on cheap fabrics that can be used once and then destroyed. The bath water used in all cases of infectious disease should be disinfected. Perhaps it is going too far to insist on the disinfection of all discharges of patients suffering from infectious disease, regardless of what the disease may be, though such a course would be preferable to treating one class of excretions and leaving untreated others which might spread the infection.

The necessity of disinfecting bed linen, towels, dishes, and other utensils will be apparent. The patient, being surrounded by infection, can not avoid transferring it in some degree to everything he touches or nandles.

To be efficient this disinfection must be done at the bedside or at least in the sick room. Picture, if you can, the patient, the source of infection, as being in the small end of a funnel and the infection spreading through the flaring bell. If you meet it at the beginning of the flare you can effectively stop it; if you let it go a little further the area over which it has spread increases rapidly, until finally it is so widespread that it is practically beyond control, and were it not for the natural disinfection already referred to the results might be appalling.

It should be stated that the proper use of disinfectants in the sick room is more easily described than carried out. If a trained nurse be in attendance it is comparatively easy. If a member of the family attend the patient, which is necessary in the majority of cases, a person who has a reasonable amount of intelligence and common sense and is able to understand instructions is desirable.

The selection of an attendant or the adoption of prophylact c measures, especially in children's diseases, can be influenced by appealing to parental responsibility. Many parents if advised as to

certain measures for their own protection scoff at the idea, saying that they are taking the risk. By putting the same idea forward as for the protection of their children they at once consider it seriously.

Regarding the disinfectant to be used at the bedside, each one will have his favorite, which may or may not be efficient. No one agent is ideal, nor can any one be applied in all cases.

The preference of the author is heat in its various forms. When applicable it is always available, efficient, and can be applied with reasonably good effect by persons incompetent to use other agents.

For sputum, nasal or other discharges (which should be received on cheap cloths) incineration is the quickest and easiest method of disinfection. Solutions containing 5 per cent phenol, 1 per cent trikresol, compound cresol solution, or other disinfectant coal tar products, are also efficient. A word of caution about the latter class may be appropriate here. Since the testing of liquid disinfectants by comparison with a standard has come into practice, it has been found that some of the alleged disinfectants have little or no disinfectant power; others run far above the standard. Some run constantly at about the same coefficient, others vary within wide limits. Do not use a substance that is claimed to be a disinfectant unless you have more than the claims of the producers to prove its worth.

For feces and urine, when other agents are not obtainable, a bucket of boiling water (about 1 gallon) added to a stool, which is then covered and allowed to stand till cool, will destroy practically all bacteria except the spore bearers.

A modified method of using heat, described by Prausnitz[1] at the Fifteenth International Congress of Hygiene and Demography, has been tried and confirmed by Linenthal and Jones,[2] of Boston. It consists of the addition of a small amount of water, preferably hot, to the stool; then fresh quicklime is added. The process of slaking raises and maintains the temperature well above the thermal death point of the typhoid bacillus for some time. Milk of lime is also an excellent disinfectant for feces and urine. The solutions already named for sputum are also effective for dejecta, but care must be taken that fecal masses are broken up to allow contact of the disinfectant with the organisms. The penetrating powers of heat will reach the interior of these masses, while the solutions may not.

Bath water used on a patient, though frequently neglected, is easy to disinfect. Heating it is very efficient. The addition of a disinfectant, such as crude carbolic acid, or other similar product, readily destroys pathogenic organisms.

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[1] Prausnitz, M. Transactions of Fifteenth International Congress of Hygiene and Demography, 1913, vol 4, p. 30.

[2] Linenthal, H., and Jones, H. W. Boston Med. and Surg. Jour., vol. 170, Jan. 8, 1914, p. 43.

For the disinfection of soiled bedding and clothing the ideal treatment is removal to a steam disinfecting chamber; but in rural communities this is not always possible. Immersion in boiling water for five minutes, or in 5 per cent carbolic acid, or other equivalent disinfectant solution, for two hours is efficient. Mattresses can be disinfected by steam under pressure, but otherwise they are hard to disinfect except by burning.

In the past much disinfection which should have been done at the bedside has been neglected in the belief that the germs would all be killed at one time by a terminal disinfection; but before time for terminal disinfection arrives the infection may have already spread to others.

2. Concerning terminal disinfection there is some difference of opinion among health authorities. All agree that when any unusual or rare infectious disease, which has not obtained a foothold in the community or country, threatens, every possible opportunity of destroying even a small amount of infection should be embraced. No one claims that any measures which may kill a single cholera vibrio should be omitted in the case of a threatened importation of cholera. The same holds true for *fumigation* to kill mosquitoes or rats when yellow fever or plague threatens.

With reference to terminal disinfection after the more common infectious diseases, such as diphtheria, scarlet fever, and tuberculosis, some authorities have taken the stand that terminal disinfection is unnecessary. Their claim is based upon the belief that the conditions which surround organisms that have been discharged from the patient's body are unfavorable for their multiplication, and that the decrease of the organisms, brought about by the processes of nature, is sufficient to reduce the number of remaining living organisms to a negligible quantity.

Since 1905 terminal disinfection after diphtheria and scarlet fever has been abandoned in Providence, R. I., and the records show that the reported prevalence of this disease has been no greater than in cities which have done terminal disinfection. In 1912 the New York City health department abandoned terminal disinfection after diphtheria, except that bedding and like goods were removed to steam disinfecting plants. This rule, however, did not apply to cases which ended fatally, or were terminated by removal to hospital or other quarters; in these cases terminal disinfection was done. At a later date the removal of bedding, etc., was discontinued. Likewise, terminal disinfection after measles, German measles, and whooping cough, was abandoned; also after poliomyelitis and cerebrospinal meningitis, except after fatal or removed cases.

The results obtained in these cities have raised the question, in the minds of health officials, whether or not disinfection, as ordinarily

practiced, is efficient. It would appear that possibly the disinfection, when done, did not disinfect, or that the forces of nature accomplished disinfection during the time necessary for the patient to recover. Possibly, and in some cases very probably, both of these conditions were present. The organisms may have been killed by the effects of drying or light, and the disinfection may have been done in a routine manner by some well-meaning employee of the health department, who had not the technical knowledge necessary to appreciate the ever-varying conditions under which disinfection must be done, and who had learned to use a certain amount of disinfectant for a given space and carried out this procedure faithfully, firmly believing that he was doing efficient work, never considering the factors of temperature, humidity, outside winds, porosity of walls, or rate of application of the disinfectant.

There is one factor that may have a bearing on the apparently favorable results obtained since abandoning terminal disinfection after certain diseases in Providence and New York; that is, the mechanical cleansing of the room. Chapin,[1] states that he "hoped the abandonment of official disinfection would cause people to do more cleansing for themselves, but there has thus far been little improvement." The handbook of the Bureau of Infectious Diseases of the New York City Department of Health states that "in diphtheria and measles, when patient recovers the sick room is thoroughly cleaned and aired."

The author believes that cleansing is an efficient method of disinfection, when properly carried out. All are familiar with the part played by sedimentation in the purification of streams. The same factor is present in the case of the air of a sick room. The law of gravity is always in effect; when the air is quiet, there is a constant tendency for dust or droplets to settle. As a result, the ceiling of the room will receive little, if any, infection. Any ledge or molding near the ceiling may receive some, but the amount found at different levels should steadily increase as the floor is approached, where the greatest amount will be found.

Thus it is seen that the place where disinfection is needed is that portion of the room which is easily reached with cleansing agents. The floors and woodwork are scrubbed, with particular attention to the ledges above door and window casements. In the present day a vacuum cleaner may be applied to the walls and ceiling generally. It is believed the results after a thorough mechanical cleansing will compare favorably with those after gaseous disinfection.

Another factor, of interest in diphtheria, is the possible absence of susceptible material. As a rule, all susceptible persons in the house

[1] Chapin, Charles V. The Sources and Modes of Infection, 1912.

or apartment are exposed before the first case is isolated and the isolation room is used for all cases before any terminal disinfection is attempted. Now that we have, in the Schick test, a reliable test for susceptibility to diphtheria, it will be interesting to note how many susceptible people escape infection if they occupy quarters vacated by a case of diphtheria after which no disinfecting procedure has been applied, provided, of course, they do not receive antitoxin. The important factor, in determining after what diseases terminal disinfection is to be done, is the length of time the organism of the disease in question can resist the action of natural agents, of which drying and light are the most important.

If standard works on bacteriology are examined as to the statements on the length of time an organism, say the diphtheria or tubercle bacillus, can exist under room conditions, one will likely find that no three agree. The statements of the same authorities concerning the time during which these organisms will resist a certain degree of heat will be found to agree much more closely. The explanation is simple: A fixed degree of heat for a certain length of time places all tests on a uniform basis and the results show accordingly. But when a drying test is recorded it is simply stated as drying "in diffused light," "in direct sunlight," "on paper," or "on fabric." No mention is made of the atmospheric temperature or humidity, the amount of light present, or the rate of drying.

That drying *per se* is not always fatal to an organism, is shown by the experiments of Vansteenberghe,[1] who rapidly dried the virus of rabies *in vacuo* and obtained a perfectly dry product which was virulent. A similar process has been used by Harris,[2] of St. Louis, except that he keeps the temperature low. Slow drying of the virus renders it noninfectious at the end of 9 to 14 days. If, therefore, one organism can be dried under certain conditions without being killed, is it not possible that others may act in the same way?

Though the apparently good results obtained since the abandonment of terminal disinfection after certain diseases are properly an incentive to search for more knowledge on this subject, it is believed the available data do not warrant the assumption that terminal disinfection is useless. I think that a majority of the health authorities of the country are not ready to discard such measures until more certain data have been obtained.

Dreyfus,[3] in advocating a standard procedure for terminal disinfection, says: "There is no doubt that the lack of uniform methods of application under fixed conditions is responsible, in a very great

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1 Vansteenberghe. Compte. Rend. Soc. Biologie, 1903, vol. 55, p. 1646.
2 Harris, D. L. Jour. of Inf. Dis., vol. 10, p. 369.
3 Dreyfus, W., Jour. of Am. Pub. Health Assoc., Nov., 1914, Vol. IV, p. 1046.

measure, for the discredit into which disinfection has fallen with a large percentage of professional men."

Rosenau[1] says: "If terminal disinfection prevents the occurrence of only a small number of cases, it would still seem to be worth while. So long as we possess such a reasonably efficient and satisfactory substance as formaldehyde, terminal disinfection should be practiced after all diseases in which the environment may become infected, even though the danger be slight."

Until the time required for natural disinfection to be accomplished has been determined, under conditions comparable with those under which the infection may exist in the sick room, the author believes it is safer to continue the use of cleansing and disinfecting procedures. The formulation of a standard procedure, to be used under standard conditions, will be a step in the right direction.

If then, as a rule, terminal disinfection is to be practiced, there next comes the question, How shall it be carried out? As already stated, good, thorough, mechanical cleansing is believed to be effective. If the walls are carefully brushed with the suction brush of a vacuum cleaner and the floors and woodwork thoroughly scrubbed with hot water and soap or, if preferred, with a disinfectant solution, a reasonable degree of disinfection will have been accomplished. This process can be applied in any sick room, in any dwelling, while the gaseous disinfectants, particularly in some of the buildings in the warmer climates, have their value reduced because of the difficulty of making the buildings reasonably tight. In rural districts only hand-operated vacuum cleaners are practicable, and in all cases the dust thus collected should be burned.

In connection with cleaning, renovation needs to be mentioned. After cleaning, a fresh coat of paint or varnish on the woodwork and floor, a renewal of the wall paper or, if the walls are bare, a fresh coat of whitewash or calcimine add their quota to the safety of the apartment.

In combating disease which is carried by animal hosts, fumigation with sulphur dioxide is the method of choice. The best results are obtained by fumigating all rooms of the structure simultaneously. Five pounds of sulphur per 1,000 cubic feet are sufficient, and should be placed in a thin layer so as to burn rapidly. If fumigating only to destroy vermin, moisture is not necessary. Exposure of 4 to 12 hours is desirable. Hydrocyanic-acid gas may be used for this purpose, but it is much more dangerous to man. Unless the process is in charge of a person with technical training and there is complete control of the structure being disinfected, its use should not be allowed.

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[1] Rosenau, M. J., Preventive Medicine and Hygiene, 1913.

The person who is to apply the disinfectant is a most important consideration. Rosenau [1] states: "It requires time, money, and expenditure of well-directed and intelligent energy to accomplish satisfactory disinfection." While ability to carry out orders is a desirable qualification for a disinfector, a certain amount of intelligence is essential.

Coming now to the disinfection process as applied in terminal disinfection against the great class of noninsect-borne communicable diseases, the chief question is, What is the best disinfectant? (The ideal disinfectant is unknown, and possibly never will be known.)

For many years formaldehyde gas has been rated as the foremost gaseous disinfectant, and it still holds its place. Its germicidal effect, when applied under proper conditions, is not denied. While not as rapid as steam or hot water, it does disinfect within a short time. Disinfection by formaldehyde does not, however, mean merely the making of a disagreeable odor. It must be used in a temperature of 65° F., or higher, and with a relative humidity of 65 per cent at the beginning of the process. It is useless to put formaldehyde gas in a room where the temperature is so low that polymerization can take place.

In practical work a sling psychrometer is sufficient apparatus to determine suitable conditions. If the temperature and humidity given above are not present they should be obtained, or some other disinfecting process should be employed. Humidity is easily raised by boiling water in the room, and this will also raise the temperature to the desired degree in most cases. Other factors to be considered are the prevailing wind, porosity of walls, and ability to keep the gas confined to the apartment to be disinfected.

Now as to the best method of liberating formaldehyde gas: There have been many devices invented for the production of formaldehyde or its liberation from solution. The tendency has been to simplify the procedure and increase the rate of liberation of gas. By liberating the gas rapidly a better effect is obtained, as the leakage is proportionately less.

A comparative study of the methods of evolving formaldehyde gas was made by McClintic,[2] who found that the greatest amount of formaldehyde was obtained from the retort or autoclave apparatus, but that the formalin-permanganate method gave nearly as large a yield with much more rapid evolution and, as a whole, better results. The method also raises the humidity of the room as the reaction proceeds.

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[1] Rosenau, M. J. Preventive Medicine and Hygiene, 1913.

[2] McClintic, T. B. Bull. No. 27, Hyg. Lab. U. S. Public Health Service, 1906.

Briefly the procedure is as follows: Ten ounces of formalin and 5 ounces of potassium permanganate are sufficient for 1,000 cubic feet of space. A large receptacle should be used, to avoid spattering, and this should be placed upon a noncombustible surface. If there be not sufficient moisture present there will be some danger of the dry gas igniting. Several receptacles in different parts of the room are more effective than one large container. The permanganate is placed in the container and the formalin poured over it. The reaction is shown by ebullition of the fluid, slight or marked according to its temperature. When once started it continues until all available formaldehyde has been liberated.

In New York City, this method is modified by using 75 grams of permanganate in 90 cc. of water, hot if possible; then 30 grams of paraformaldehyde are added. This is sufficient for 1,000 cubic feet. This method makes less weight to carry, as the water is obtained at the place where disinfection is to be done. The paraformaldehyde is more stable than formaldehyde solution, the latter seldom containing the required 40 per cent.

At present the price of permanganate makes the cost of this method rather high. Whether we shall find a substitute as efficient as permanganate has not yet been fully determined. The formalin-aluminum-sulphate-lime method does not give as much gas as the permanganate method.

Dixon [1] reports favorable results by substituting sodium dichromate and sulphuric acid for potassium permanganate. The acid and formaldehyde solution are mixed and allowed to cool. This solution is then poured over the crystals of sodium dichromate, spread in a thin layer in a large container. The proportions are:

Sodium dichromate	oz.	10
Saturated solution formaldehyde gas	pint	1
Sulphuric acid, commercial	oz.	1.5

Controls.

A suitable control test should be employed to determine the efficiency of the disinfection. A simple and efficient test is made by the Wilson method: A small folder of pasteboard in which there is pasted a strip of filter paper is prepared and sterilized. The filter paper is touched with a drop of broth culture of *B. prodigiosus*, or other harmless organism, and, after drying, is exposed in the room to be disinfected, not too close to the source of the gas. When the room is opened, the filter paper is removed from the folder with sterile forceps and planted in broth, and then incubated for 24 hours. If a chromogenic organism, such as prodigiosus, is used, the color tells whether the growth is due to unkilled test organisms or to accidental

[1] Dixon, Samuel G. Jour. A. M. A., Sept. 19, 1914, Vol. LXIII, p. 1025.

contamination. The use of such control tests is a check on efficiency, and the disinfector learns to be more thorough and constantly strives to improve his results.

There is one method being put forward at present by the manufacturers of the high coefficient disinfectants, viz, the general spraying of all surfaces of a room with a solution or emulsion of some particular disinfectant. Most of these preparations are of an oily nature and many have a disagreeable odor. If the walls of a papered room are sprayed with them, the oily stains left necessitate renewal of the wall paper; if the room be calcimined, the wall must be recalcimined. If the odor that remains is disagreeable an attempt may be made to mask it with something more agreeable.

No attempt has been made to dwell to any extent on the use of the physical agents as disinfectants. There is little to discuss concerning heat, the best physical disinfectant. All are agreed that, when it can be applied, it is most rapid and efficient. The regret is that it can not be used under all circumstances.

At present the market price of disinfectants is decidedly fluctuating. The European war has caused a general advance in prices, in part because of the scarcity of certain products that have heretofore been imported, and in part by the lessening of competition among producers. It is, therefore, useless to expect to accomplish disinfection by chemical substances as economically as was possible one year ago. The cost of heat, however, has not advanced and consequently, from an economic viewpoint, heat should be employed on a wider scale.

Summary.

Briefly summarized, the points to be emphasized are:

1. Disinfecting procedures, properly applied, have an important part in the prevention of communicable diseases.

2. Their efficiency decreases as the distance between the place of origin of the infection (the patient) and the point of their application is increased.

3. Natural disinfection, or the destruction of infection by processes of nature, increases in efficiency in direct proportion to the length of time and the degree to which the processes (drying, sunlight, etc.), are allowed to act.

4. The point at which natural disinfection becomes sufficiently nearly complete to warrant the discontinuance of terminal disinfection should be determined under more exact conditions than have obtained in the past.

5. The choice of disinfectants must be made with due consideration of conditions, always bearing in mind that a good mechanical cleansing is one of the efficient means of disinfection. For gaseous disinfection, formaldehyde, evolved by the formalin-permanganate method

under proper conditions of temperature and moisture, is the simplest and most efficient method.

6. Control tests should be used to check the efficiency of the disinfection.

7. Though the results obtained in some cities since abandoning terminal disinfection after certain diseases seem to show that heretofore much useless disinfection has been done, it is not felt that the evidence thus far adduced, fully justifies its discontinuance.

INTESTINAL INFECTIONS.

THE SCHOOL GRADES ATTAINED BY 2,166 WHITE SCHOOL CHILDREN (1,062 BOYS, 1,104 GIRLS) IN THE CITY OF X, CLASSIFIED BY AGE, SANITATION, AND INTESTINAL PARASITES.

By C. W. STILES, Professor of Zoology, United States Public Health Service.

In a former article [1] it was shown that the school children in the City of X—— who live at homes provided with sewer connection (group S), but without privies, average a lower percentage of infection with intestinal parasites and a lower percentage of unconscious coprophagia than do the children in the same city who live at homes provided with privies (group P).

In the present article, the same white children are classified by age, school grades, and sanitation (in respect to sewer, group S, or privy, group P), to see whether there is any more rapid advancement in school grades by either group—S. children or P. children.

The legal age for entering the first grade at school is 6 years, chronological age, and there are 12 grades in all (including the 4 high school years); each grade is theoretically of 1 year duration in the child's career. Accordingly, a child of 6 years flat to (but not inclusive) 7 years flat (namely, during his seventh year of life) is in his first theoretical school year, and a pupil of 17 years flat to (but not inclusive) 18 years flat is in his twelfth theoretical year of school age. The legal grade that a child is permitted theoretically to enter at a given chronological age thus represents his theoretical school year. Taking these data as basis, it is an easy matter to estimate the percentage of the theoretical legal school advancement a given group of children has made. For instance, if 10 children of 6 years of age (namely, in their seventh year) are in the first grade, they have advanced 100 per cent of the theoretical legal standard; but if 10 children of 7 years of age (in their eighth year) are in the first grade, they have advanced only 50 per cent of the theoretical legal standard, for they represent a theoretical total of 20 grades, but an actual total of only 10 grades.

[1] Public Health Reports, 1915, v. 30 (27), July 2, 1915, pp. 1991-2002.